

# Solutions: one-page cheat sheet

NEET Chemistry · Unit 5 · Physical Chemistry

## 1 · Concentration recap

|                        |                                                                     |
|------------------------|---------------------------------------------------------------------|
| <b>Mass-based</b>      | mass %, ppm, mole fraction, molality: do <b>not</b> change with $T$ |
| <b>Volume-based</b>    | molarity falls on heating                                           |
| <b>Mole fraction</b>   | $x_1 + x_2 = 1$                                                     |
| <b>Solid solutions</b> | brass (Cu–Zn), bronze (Cu–Sn), $H_2$ in Pd, Na–Hg amalgam           |

All formulas: see the Some Basic Concepts cheat sheet.

## 2 · Henry's law

$$p = K_H x$$

|                                 |                                                                                                                 |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Solubility</b>               | at the same $p$ , <b>higher <math>K_H</math> means lower solubility</b>                                         |
| <b>Effect of <math>T</math></b> | $K_H$ rises with $T$ , so gas solubility falls                                                                  |
| <b>Uses</b>                     | soda bottled under pressure; scuba tanks use helium (very low solubility, avoids the bends); anoxia at altitude |

## 3 · Raoult's law

$$p_i = p_i^\circ x_i, \quad p_{\text{total}} = p_1^\circ + (p_2^\circ - p_1^\circ)x_2$$

|                        |                                                                      |
|------------------------|----------------------------------------------------------------------|
| <b>Vapour phase</b>    | $y_i = p_i/p_{\text{total}}$ ; richer in the more volatile component |
| <b>Non-vol. solute</b> | $p_{\text{soln}} = p_1^\circ x_1$                                    |

## 4 · Ideal and non-ideal solutions

|                        | Ideal              | Positive dev.     | Negative dev.        |
|------------------------|--------------------|-------------------|----------------------|
| A–B forces             | $\approx$ A–A, B–B | weaker            | stronger             |
| $p_{\text{obs}}$       | = Raoult           | > Raoult          | < Raoult             |
| $\Delta_{\text{mix}}H$ | 0                  | > 0               | < 0                  |
| $\Delta_{\text{mix}}V$ | 0                  | > 0               | < 0                  |
| Azeotrope              | none               | minimum boiling   | maximum boiling      |
| Example                | benzene + toluene  | ethanol + acetone | chloroform + acetone |

**Azeotropes** 95% ethanol (351.15 K, minimum); 68%  $HNO_3$  (393.5 K, maximum). Cannot be separated by fractional distillation.

**Trap** · Chloroform + acetone: H-bond  $C-H \cdots O=C$  makes A–B stronger, so negative deviation.

## 5 · Colligative properties

$$\frac{p_1^\circ - p_1}{p_1^\circ} = x_2, \quad \Delta T_b = K_b m, \quad \Delta T_f = K_f m$$

|                         |                                                                        |
|-------------------------|------------------------------------------------------------------------|
| <b>Water</b>            | $K_b = 0.52, K_f = 1.86 \text{ K kg mol}^{-1}$                         |
| <b>Osmotic pressure</b> | $\Pi = CRT = \frac{w_2 RT}{M_2 V}$ (uses molarity, works at room $T$ ) |
| <b>Molar mass</b>       | $M_2 = \frac{1000 K w_2}{\Delta T w_1} (K = K_b \text{ or } K_f)$      |
| <b>Equal mass</b>       | at the same $w$ and $V, \Pi \propto 1/M_2$                             |

## 6 · Osmosis

|                        |                                                           |
|------------------------|-----------------------------------------------------------|
| <b>Isotonic</b>        | equal $\Pi$ ; no net flow                                 |
| <b>Hypertonic</b>      | higher $\Pi$ ; cell shrinks (plasmolysis)                 |
| <b>Hypotonic</b>       | lower $\Pi$ ; cell swells                                 |
| <b>Reverse osmosis</b> | applied pressure > $\Pi$ pushes solvent out; desalination |

## 7 · van 't Hoff factor

$$i = \frac{\text{normal molar mass}}{\text{observed molar mass}} = \frac{\text{observed property}}{\text{calculated property}}$$

|                        |                                                                                    |
|------------------------|------------------------------------------------------------------------------------|
| <b>Use</b>             | multiply each colligative property by $i$                                          |
| <b>Dissociation</b>    | $i = 1 + (n - 1)\alpha$                                                            |
| <b>Association</b>     | $i = 1 - \left(1 - \frac{1}{n}\right)\alpha$ ; dimer in benzene gives $i = 0.5$    |
| <b>Full ionisation</b> | NaCl, $MgSO_4$ : 2; $K_2SO_4$ , $CaCl_2$ : 3; $K_4[Fe(CN)_6]$ , $Al_2(SO_4)_3$ : 5 |

## Seen in NEET 2025

Highest boiling point among 0.015 M glucose, 0.01 M urea, 0.01 M  $KNO_3$ , 0.01 M  $Na_2SO_4$ ?

$$i \times m : \quad 0.015, 0.010, 0.020, 0.030$$

**$Na_2SO_4$**  has the most particles.

## Seen in NEET 2024

$\Pi$  vs  $C$  is a straight line of slope  $25.73 \text{ L bar mol}^{-1}$ . Find  $T$ .

$$T = \frac{\text{slope}}{R} = \frac{25.73}{0.083} = 310 \text{ K} = 37^\circ\text{C}$$

## Seen in NEET 2020

$K_f(\text{benzene}) = 5.12$ ; solution is 0.078  $m$  in a non-electrolyte.

$$\Delta T_f = K_f m = 5.12 \times 0.078 = 0.40 \text{ K}$$

## Six traps to remember

- Higher Henry's constant means **lower** gas solubility.
- Only molarity changes with temperature.
- Positive deviation: weaker A–B forces, minimum-boiling azeotrope.
- Rank colligative properties by  $i \times$  concentration, not concentration alone.
- Osmotic pressure at equal mass is highest for the **smallest** molar mass.
- Dimerisation gives  $i < 1$ ; dissociation gives  $i > 1$ .